

# Including accessibility in higher education curricula for ICT

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## Abstract

This paper describes the successful experience carried out by professors of the CETTICO research group of the Technical University of Madrid to incorporate accessibility in the curricula of higher education in ICT in Spain. The paper covers the legal requirements to include accessibility in curricula in Spain, the courses and modules that we have been teaching through the years and the teaching techniques and tools that we have been using.

## 1. Introduction

Education is considered to be one of the key actions to enhance the integration of persons with functional diversity (persons with disabilities) in society and, in particular, in higher education institutions [1]. Both administrative and teaching staff of Universities need to know about functional diversity and accessibility in order to provide good service to all their students. In addition, it is essential that students also have knowledge on these issues to better accommodate their fellow students with functional diversity. In fact, the students of today will be the professionals of tomorrow and thus investing in education on accessibility is investing in better integration in the future.

Since 2003, in Spain there is a legal obligation to include contents on accessibility and design for all at all levels of the education system, including higher education [2]. Since several years before that obligation, the research group CETTICO of the Computer Science School of the Technical University of Madrid (UPM) has pioneered the introduction of such contents through several academic activities. These efforts have been

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maintained over the time with a strong cooperation with the Sidar Foundation, cooperation that started in 2002. This paper describes our successful experience.

The contents of the paper are as follows. In the next section, we will provide an overview of the Spanish policies concerning curricula on functional diversity and accessibility. Then we will summarize all the educational activities that CETTICO has been performing since 1995. Section 4 will describe the main teaching techniques and tools that we have been using over the time. Finally, section 5 will provide some concluding remarks.

## **2. Spanish policy on accessibility curricula**

Spain has a long history of accessibility-related legislation, initially on the built environment domain and, later on, on the Information and Communication Technology (ICT) field. The major legislative action concerning the incorporation of accessibility and design for all curricula was the Law 51/2003 on equal opportunities, non-discrimination and universal accessibility for persons with disabilities, published in December, 2003 [2].

The legal requirement for the inclusion of accessibility in curricula can be found in the tenth final disposition of that law. This disposition says that the Spanish government had two years to develop accessibility curricula to be incorporated in all educational levels, including universities, to train professionals in the fields of built environment, buildings, infrastructures, transport, communications, telecommunications and services of the information society.

Some years later, in October 2007, the Spanish government published Royal Decree 1393/2007 [3] to regulate the university degrees in Spain to accommodate their integration in the European Space of Higher Education, also known as the “Bologna process”. In that Royal Decree, article 3, section 5 says that one of the general principles to be applied when designing university curricula is the respect and promotion to human rights, and the principles of universal access and design for all and that those curricula shall include contents related to those rights and principles.

In the field of ICT and, in particular, computing, it has to be noted that the Spanish universities were aware of this regulation. For example, the Conference of Directors and Deans of Computing Schools (CODDI) defined in 2007 the learning outcomes of the curricula in computing [4], including “being able to design, develop, evaluate and guarantee the accessibility, ergonomics, usability and security of computing systems, applications and services”.

Taking all of this into account, several Spanish universities have in fact incorporated accessibility-related contents in their curricula, although with limited success, with 66% of universities that completely failed to comply with Royal Decree 1393/2007, as has been recently reported by the SOLCOM association [5].

This is the policy environment in which our efforts of incorporating accessibility in the computing curriculum have been done by CETTICO, with the support of the Sidar Foundation, as described below.

## **3. Educational activities in universities by CETTICO and Sidar**

The information and communications technology research group (CETTICO) [6] was created in 1988 having accessibility as one of its main goals. The group started by developing software for blind users, and later on spread its activity field to other types of disabilities. Being part of a University, the group also had a goal to incorporate its results into the teaching activity and it started by specific seminars that were integrated in the computing curricula of the Computer Science School of the Technical University of Madrid.

The Sidar Foundation was created in 2002 to provide support for the activities of the SIDAR seminar that, until then, was under the Spanish Royal Patronage of Disabilities. Since its creation, the Sidar Foundation has closely cooperated with the research group CETTICO in research and education.

Below there is a summary of teaching activities related to accessibility, organised by curricula.

### *3.1. Computer science degree – 1983 curriculum*

When CETTICO was created, the Computer Science School of the UPM had a 6-year curriculum on **computing (called “Licenciado en Informática” in Spanish)** that was officially approved by the Spanish Government in 1983. The curriculum was for the most part fixed and could not be changed. The only room for **changing contents was through two modules called “seminars”, one for 5th year students and another one for 6th year students.** Professors of our school could propose individual seminars to be included as part of these modules.

In 1995 CETTICO created one such seminar called **“Information Technologies for Disability”**. The seminar had 10 teaching hours concentrated in one week. The contents of the seminar consisted on awareness sessions (often with participation of persons with disabilities) and then several presentations about the projects that were being developed at CETTICO at the time. The evaluation of the seminar was based only on attendance to the lectures, as was the case for all the other seminars.

This seminar existed since 1995 until the year 2000 where it was closed because there were no more students in the 6-year curriculum due to the implementation of a new curriculum as described below.

### *3.2. Computer science degree – 1996 curriculum*

In 1996 a new curriculum on computer science was developed and published in order to adapt to changes in the legislation on university degrees. That time it was a **5-year curriculum (named “Ingeniero en Informática” in Spanish)** that again had no formal reference to accessibility or even human-computer interfaces. This new curriculum was also immovable but the Spanish legislation allowed universities to create **“free option” modules** to complement the training of the students. These free option modules could easily be proposed by professors and only required acceptance at Department level.

In 2003, which was the European Year of Persons with Disabilities, the professors of CETTICO decided to create a **free option module called “Design for all. Accessible web design”**. It was a **45-hour module** that included several lectures (including an awareness session) and a practical exercise consisting on the development of a small-sized (~5 pages) accessible web site.

In this module we cooperated with the Sidar foundation and used two materials: Contramano [7], a fictitious web site to demonstrate accessibility bad practices and how to solve them, and Hera [8], an online tool for web accessibility evaluation. These will be described in section 4 below.

During the first years, the evaluation of the module was mainly based on the practical exercise and we evaluated the accessibility, content, usability and syntactic validation of the web site. Later, we added a web accessibility evaluation exercise and some collaborative learning sessions that were also evaluated.

This module existed since 2003 until the year 2010, when we decided to close the module due to our academic activities in the new curricula (degree and master) that had started in 2008.

### *3.3. Computer science degree – 2008 curriculum*

Our School had to change again the computing curricula to accommodate the integration into the European Space of Higher Education and the corresponding Spanish legislation (Royal Decree 1393/2007). The result was a two-level curriculum, with a **4-year degree (named “Graduado en Ingeniería Informática” in Spanish)**, several 1-year master degrees and several PhD programs. The 4-year degree curriculum was officially approved in 2008 and teaching started in 2009.

The professors of CETTICO had an active participation in the development of the new 4-year degree curriculum in order to guarantee that all students in our school learned contents related to accessibility and design for all, as was requested by the Spanish legislation. The process was long and required many negotiations and the solution at the end was to incorporate accessibility-related contents in a mandatory module on human-computer interaction.

This module on human-computer interaction belongs to the third year of the curriculum and has 6 ECTS (European Credit Transfer System) that in our university are the equivalent of approximately 160 student working hours. In this module we teach the user-centred design approach and the students, in a team-based effort, have to develop a system's user interface. For that they have to perform contextual analysis, design of low-fidelity prototypes, usability testing of low-fidelity prototypes, design of a high-fidelity prototype and, finally, usability testing of the high-fidelity prototype.

The accessibility and design for all contents have been integrated in this user-centred approach. When teaching about the context of use and the users, we do an awareness session and a collaborative session on functional diversity. When teaching about the design of user interfaces, we do collaborative sessions on accessibility guidelines. Finally, when teaching about usability evaluation, we include accessibility evaluation based on heuristics and guidelines.

The students are evaluated both on their individual efforts in the classroom (including participation in the accessibility-related sessions) and their project performance, which includes an accessibility evaluation.

### *3.4. Computer science master degree*

To accommodate the integration into the European Space of Higher Education and the two-level curriculum, our School has designed several master degrees, some with a professional goal and some with a research goal. The research masters have as the main goal to introduce students into research activities. Usually, when students finish the research master they go into a PhD program. Research masters last one year and have 60 ECTS. Depending on the master degree, the students have to attend a number of modules, a number of seminars (short modules about latest trends in research) and they have to develop a master's final project (15 ECTS).

The professors of CETTICO proposed a module called “Challenges of Accessible Computing for People with Functional Diversity” in the Master in Software and Systems. That module has 4 ECTS, which means over 100 student working hours, and is taught in the first semester. This Master started in September 2010, so we have taught it already twice.

In this module, students specialize in ICT accessibility for persons with functional diversity, focusing on the latest research topics in the field. They are introduced the basic concepts of ICT accessibility: functional diversity, design for all, legislation, technical standards and ICT product and service accessibility conformance assessment. Students then further examine the current challenges in accessibility to ICT, according to relevant international conferences and publications.

The students are evaluated on several aspects:

- Tests on some of the theoretical contents of the course.
- Participation in collaborative sessions on ICT accessibility standards.
- Practical exercises on different topics: change proposals for an accessibility standard; accessibility assessment of one web page; proposal of changes in one ICT development methodology to integrate a user centered approach; a summary on the state of the art on one topic related to ICT accessibility.

In addition, professors of CETTICO offer a 1-week seminar in the Master in Software and Systems titled “Software Accessibility and Children with Special Educational Needs: Challenges for Inclusive Education”, which has 1 ECTS. In this seminar, students are taught how learners have special educational needs (SEN) when they find it harder than their peers to access education stipulated in the curriculum for their age group.

They often require adaptations of the environment, materials or curriculum. Our students learn that learners with SEN should be educated with peers without SEN (inclusive education) to encourage socialization and that ICT are extremely useful to reach that goal, if accessibility guidelines are considered. The students are evaluated by preparing a paper for oral presentation.

Finally, we plan to teach a module about “Accessible Web Design” in the professional Master in Informatics Engineering. This module is still under development and we expect to start it during the next academic course.

### *3.5. Other courses*

The professors of CETTICO have also participated in several other courses at different universities, covering the topics of accessibility and design for all. Some of them are outlined below:

- New Technologies and Advanced Computing Helping the Disabled. Summer course aimed mainly to university students, organized by the International University of the Atlantic, with the participation of the University of A Coruña and the UPM. It took place in Pontevedra in 1997, with a work load of 30 hours in one week. Over 100 students attended the course that covered different topics on accessibility on different areas, mainly with theoretical lessons but also with some practical and demonstration sessions.
- Computing systems for Helping Functional Disabled People. It was a "free option" module aimed to 5th year students at the Higher Technical School at Alfonso X University (Madrid). 40 students attended the 30-hours module during four months in 1999. The module has both a theoretical and a practical part.
- Introduction to Design for All in ICT. It was a "free option" module aimed to 5th year students at the School of Telecommunications at UPM, organized by the Vodafone Cathedra. It was a 35-hours module during four months, and the module was attended by 20-50 students from 2003 to 2009. It had a theoretical-practical content and the participation of professors from the School of Telecommunications (UPM), the School of Computing (UPM), the Sidar Foundation and others.
- Design for All. Accessible Web Design. Summer course organized by the Board of European Students of Technology (BEST). It was a 27-hours theoretical-practical course in one week in 2004 and 20 European students attended.
- Accessible Web Design. European students interchange module belonging to the ATHENS programme. It is a 1 ECTS module taught in one week. Each year 24 European students attend the theoretical-practical course. We started this course in 2005 and we keep teaching it every year.
- ICT in Personal Autonomy, Dependence and Accessibility. Summer course organized by the University of A Coruña and the UPM in 2006 at Pontevedra. It was a 30-hours module during one week and over 50 students attended the module. The content was mainly theoretical, complemented with some practical and demonstration sessions.
- ICT in Disabled People: the Road to Personal Autonomy. Summer course organized by the Menéndez Pelayo International University in 2009 in A Coruña. It was a 30-hours module during one week with professors from different companies. The contents of the course were mainly theoretical.

## **4. Teaching methods and tools**

### *4.1. Awareness by persons with disabilities*

We usually start our courses with an awareness session consisting of a lecture given by a person with disabilities. The goal of the session is to make them think that persons with functional diversity are being discriminated today, and that the challenge of designing for diversity will produce better designs at the end, designs that will be more useful for more users.

This is a very important session at it has been both motivating and thought-provoking for our students. They typically approach our courses differently after that session, having a better understanding of why accessibility is important and why they should design accessible solutions in the future.

People from the Independent Living Forum [9] usually collaborate with us in these awareness sessions, providing their personal viewpoint on functional diversity and civil rights.

#### *4.2. Contramano*

Contramano is a fictitious web site for left-handed people, offering information, games, curiosities and an electronic shop of specially created goods.

This web site, developed by the Sidar Foundation, is useful for both teachers and students. It is a comprehensive web site for students to review and modify. They can do short practical exercises on accessible web evaluation. It is also a complete collection of bad practices giving simple examples for all of the Web Content Accessibility Guidelines 1.0 (WCAG) checkpoints, techniques to be avoided, and typical accessibility barriers. Contramano consists of [7]:

- Contramano incorrect web site: This version consists of a web site full of accessibility and usability mistakes. Each of the pages was designed with the goal of violating some of the WCAG checkpoints, allowing the teacher to show examples of bad practices and enabling the student to review and correct those problems.
- Contramano correct web site: It is the accessible version of the web site, keeping as much of the original aesthetics as possible. The accessibility problems of the original site have been solved in this version, so the main goal is to show how to remove the accessibility barriers of the original site and to create a site that conforms to WCAG 1.0.
- Exercises: There is a set of 67 exercises corresponding to examples of bad practices in the application of the WCAG 1.0 checkpoints. These exercises can be navigated in three ways: by the sorting order of the related checkpoints, by the type of elements they refer to or by priority order. This way, students can follow the order proposed by the teacher or their own preferred order when working on their own. The exercises consist of small fragments of the Contramano web site, each focused on one of the WCAG checkpoints and accompanied by the required files. In this way the student only has to worry about the checkpoint the exercise deals with.
- Teacher's guide: Teachers of web accessibility courses are experts with extensive knowledge of WCAG. However, even an expert will not always remember the full text of each of the checkpoints and, furthermore, will not always recall which pages of Contramano provide examples for each of the checkpoints. For this reason, we have developed a teacher's guide accompanying the Contramano site. This guide contains, for each of the checkpoints, its identifier, its priority level, its full text and the failure examples in Contramano. The checkpoints can be navigated in the same orders as described for the exercises. In addition, the guide contains specific help about evaluation techniques for each of the checkpoints.

As the original version of Contramano was designed for teaching the now outdated WCAG 1.0, in the Research Group CETTICO we are completely redesigning the Contramano website to teach WCAG 2.0. We have almost finished the correct web site, an accessible version conforming to the WCAG 2.0.

We are now working in two different versions of the incorrect versions of Contramano. The first version will contain accessibility mistakes that cannot be detected programmatically by accessibility assessment tools. The second version will, in addition, include mistakes for every success criteria of WCAG 2.0. The goal of having these two incorrect versions is to demonstrate the students that automatic tools should not be solely be used to assess the accessibility of a web page.

The Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C) has recently published a similar tool for learning web accessibility, called the "Before and After Demo" (BAD) [10]. It is a multi-page

resource that shows an inaccessible website and a retrofitted version of this same website. Each web page includes inline annotations that can be activated to highlight some of the key accessibility barriers or repairs. Each web page is also accompanied by an evaluation report to inform the developers on the level of conformance to WCAG 2.0.

#### *4.3. Hera and Hera-FFX*

HERA is a multilingual online tool developed in 2003 by the Sidar Foundation that performs a preliminary automatic analysis of a web page based on WCAG 1.0 and then provides support for the complete manual evaluation process. Its main features includes a summary of results, help on checkpoints, instructions for evaluation, modified page view and code view for helping the evaluation, evaluation results forms and a report generation module [11].

In 2009, Hera-FFX 1.0 [12] was presented as a Firefox add-on for semi-automatic web accessibility evaluation based on WCAG 1.0 and developed by CETTICO. The main goals behind the design of Hera-FFX were to keep a similar level of usability of the one found in Hera and to be flexible enough so it could easily be extended with requirements and tests from other standards or recommendations. Hera-FFX also allows evaluating local pages, pages with restricted access and even pages after being rendered by the user agent.

As WCAG 2.0 was published in December 2008, we started to update Hera-FFX and finally we presented the new version in 2011 [13] which includes the entire main features of HERA and Hera-FFX 1.0, but with a high fidelity with the WCAG 2.0 structure. The actual version includes a few automatic evaluations of several techniques and failures, but we are working to include more automatic tests to ease the manual evaluation process and to update the tool with the new techniques and failures published by the W3C.

Hera-FFX 2 is being used by the students attending our courses. The students are set the exercise of evaluating one web page. The use of this tool has proven to be very useful to speed the evaluation process and to help the students to learn the WCAG 2.0 details while evaluating the accessibility of a web page.

#### *4.4. Collaborative learning*

We have been using WCAG 2.0 since it was published in December 2008. Given the essential differences between WCAG 1.0 and WCAG 2.0 we decided to change our teaching approach. Until then we combined traditional lectures with a short project consisting of developing a small-size accessible web site.

For WCAG 2.0 we decided to incorporate a new teaching method: collaborative learning. As collaborative learning technique we use jigsaw-based sessions [14]. These sessions consist of providing the students with short pieces of documentation (excerpts of WCAG 2.0) and making them work together to learn in a collaborative way as follows:

1. The students are distributed into groups of three people. Each member of the group is given a different fragment of documentation.
2. Each student reads individually his or her piece of the documentation.
3. Then all the students from different groups that have read the same documentation meet together and share their views on that document.
4. As individual work each student prepares a short presentation of his or her document.
5. The original groups meet to share information about the different documents. Each student presents his or her document to the other group members.
6. The session ends with oral presentations of the documents. The presenters of each document are students that did not read the corresponding document. The group is evaluated with respect to the presentations made by their members.

Depending on the course, we had a different number of two-hour jigsaw session plus one summarizing one-hour session to discuss with the teacher the content of the collaborative session. The first session is always centered on WCAG 2.0 principles, guidelines and success criteria and the other sessions (from one to three) are focused on different sets of techniques and common failures.

This learning method has proven to be quite successful, as students get a better understanding of WCAG 2.0 that they would if we just used lectures. Collaborative learning implies for the students a high degree of effort in the classroom, but this effort pays as they improve their understanding of the documents being discussed.

## 5. Conclusions

This paper has described the pioneering experience of professors of the CETTICO research group that have been including accessibility contents in higher education on computing since 1995. The activities have covered optional and mandatory courses, at degree or master levels, and as part of official computing curricula or as a standalone courses.

We believe that teaching about accessibility is an essential activity to reach the final goal of having an inclusive society, which considers human diversity as a challenge to design better products and services. If professionals of any discipline know about functional diversity, accessibility barriers and accessible design, they will be able to create much better solutions when they enter the workforce.

One important aspect that needs to be mentioned is the issue of championing as a way of incorporating accessibility in the curriculum. Our school has provided education in accessibility because CETTICO worked in that field since 1988 and the professors working in CETTICO have always been interested in incorporating their research activities in accessibility as part of the computing curricula of the UPM. It was through this championing process that the researches of CETTICO managed to succeed in finally incorporating the teaching of accessibility and design for all in a mandatory way for all the students of the 2008 curriculum in computer science. We know that other Spanish Universities have also reached the same goal because they had very active research groups in the area. But many other Universities did not have these active groups in accessibility, and this fact has been reflected in the poor degree of application of the Spanish legislation that mandates the **inclusion of accessibility in curricula, as demonstrated by the SOLCOM's report [5]**.

Finally we would like to also highlight the cooperation that we have had with the Sidar Foundation and with representatives of groups of persons with functional diversity. They have helped us to greatly improve the contents and approach of our courses.

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